

# ZooKeys, unlocking Earth's incredible biodiversity and building a sustainable bridge into the public domain: From “print-based” to “web-based” taxonomy, systematics, and natural history

## ZooKeys Editorial Opening Paper

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Received 15 May 2008 | Accepted 30 June 2008 | Published 4 July 2008

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**Citation:** Penev L, Erwin T, Thompson FC, Sues H-D, Engel MS, Agosti D, Pyle R, Ivie M, Assmann T, Henry T, Miller J, Ananjeva NB, Casale A, Lourenço W, Golovatch S, Fagerholm H-P, Taiti S, Alonso-Zarazaga M (2008) ZooKeys, unlocking Earth's incredible biodiversity and building a sustainable bridge into the public domain: From “print-based” to “web-based” taxonomy, systematics, and natural history. ZooKeys Editorial Opening Paper. ZooKeys 1: 1-7. doi: 10.3897/zookeys.1.11

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### Abstract

Publishing taxonomic and systematics studies in the digital era faces major challenges and requires new approaches, many of which are currently stimulating spirited discussions amongst taxonomists and sys-



tematists. New amendments to the International Code of Zoological Nomenclature are expected to regulate electronic publishing of new taxa and create a standard form for their registration (ZooBank). Responding to a perceived need, this editorial announces establishment of *ZooKeys* – a new online and print journal in zoological taxonomy and systematics, which aims to quickly respond and adapt to the newest developments in taxonomic publishing. Open Access is accepted as mandatory for *ZooKeys*. The rationale for and concept of *ZooKeys* is discussed in detail.

## Keywords

Taxonomy, systematics, online publishing, ZooBank, open access

## Introduction

The world around us and the living things that occur in it have always been of critical interest to humankind, both in terms of sustenance for the body and for the mind. Ever since the dawn of written history, or at least as far back as the Greeks more than 2,000 years ago (Aristotle), humans have tried to organize and disseminate knowledge about their surroundings. As humankind spread from its initial roots, more and more biodiversity was discovered, so much so that comprehending it became a significant challenge. This year, we celebrate the 250<sup>th</sup> anniversary of the 10<sup>th</sup> edition of *Systema Naturae* (Linnaeus, 1758); the first modern attempt to bring order to our understanding of what we now call biodiversity. Now, here in *ZooKeys*, we build a bridge that will launch knowledge of our rich natural heritage into the future with all the technologies presently available, and continually scoping out those for the future.

With his 10<sup>th</sup> edition of the *Systema Naturae*, Linnaeus created a method of assigning names (nomenclature) to biological organisms, organized in a structured hierarchy (classification). The result was an effective means for global communication about biodiversity. For each similar group of organisms, what we call today a species-level taxon, he provided a diagnosis. From this system one knew how to identify the taxon and could distinguish it from other taxa, and additionally could locate a summary of what was already known and published elsewhere on its biology, distribution, history of recognition, and the total accumulative body of data documented for the species.

Linnaeus maintained his system for another two editions, but as knowledge about the diversity of life increased, this undertaking became too great for a single person. Hence, the task was divided among his students, such as Fabricius, who wrote *Systema Entomologiae* (1775); but as the rate of knowledge accelerated, these summaries became fewer and more limited in scope. Today, thousands of works are published annually and most cover only a few taxa. For the most part, the means of disseminating these works has changed little from the time of Linnaeus; i.e., printing with ink on paper, with archival sets (or sometimes CD's distributed to a specified number of libraries)! Technologies for data synthesis and information dissemination, however, have changed rapidly in the last half-century, more so in the last decade (even more



so in the last year). Thus, the goal of one comprehensive, universal and universally-accessible source of information about life is now achievable. *ZooKeys* sets out to be a holistic bridge that facilitates a transition from the past and even the present to the future of unlocking biodiversity's secrets.

## **Taxonomy in the digital era**

The future of taxonomy in the digital era is widely discussed in several fora and in the literature (e.g., Polaszek, Agosti et al. 2005, Polaszek, Alonso-Zarazaga et al. 2005, Wheeler 2007, 2008). Several recently published papers may be regarded as the first “case studies” of the taxonomy of the future. The first one was published on 1 January 2008 in *Zootaxa* (Pyle et al. 2008), followed by another two in the same journal (Johnson et al. 2008, Deans & Kawada 2008). The fourth, published on 28 May 2008 in *PLoS ONE* (Fisher & Smith 2008), has served as the basis for lively discussion about the need for clearer rules concerning electronic publication of nomenclatural acts as governed by the ICZN Code. All of these papers attempt to set new standards for taxonomic publishing and incorporate some already widely accepted user-friendly features such as embedded hyperlinks, e-referencing, etc. However, at the same time they offer a solution to the problem of universal registration of new taxa within a central repository (ZooBank), links to images of descriptive characters such as morphology (MorphBank) or DNA sequences (GenBank), barcoding of the type specimens and linking to their depositories. Most important, however, seems to be the use of the taxonomic domain specific XML mark up schema (TaxonX) to mark up the content of the publication, which means that XML can be read by machine and imported into other projects, such as [plazi.org](http://plazi.org) and through it to GBIF databases (<http://data.gbif.org/datasets/provider/241>) (D. Agosti, cf. comment from 29 May on *PLoS ONE*).

*ZooKeys* will begin modestly by utilizing the best of current technologies for the production and dissemination of scientific information. *ZooKeys* will develop and deploy in conjunction with other initiatives (ICZN, TDWG, TaxonX, TaXMLit, DarwinCore and others) common data formats, so information published can be readily integrated into other community activities, such as ZooBank, GenBank, Global Biodiversity Information Facility (GBIF), MorphBank, Tree of Life, Catalogue of Life (Species2000 & ITIS) and the Encyclopaedia of Life (EOL). Eventually, all critical data and general information about animals will be accessible to all through the Internet. This is our vision and herewith we take some important steps toward fulfilling it.

## **Open Access and its implication in taxonomy – ZooKeys approach**

The editorial policy of *ZooKeys* aims to adhere strictly to the principles of Open Access (OA) and free exchange of information, which means a direct, barrier-



free, online dissemination of scientific results at no charge to the reader. Pursuing the cutting-edge technologies in the publishing realm, we shall continue to be in constant conformity with the current developmental changes in systematic zoology and in the ICZN, in particular. The editorial policy will pursue the following main objectives:

- High credibility and impact, achieved through an eminent editorial board and rigorous peer-review procedure
- High speed of publication, ranging between 2-3 weeks on average after a manuscript is accepted for publishing
- High-level online publishing technology – digital object identifiers (DOI), search and browse tools, e-citation and cross-referencing (CrossRef), indexing in major repositories worldwide, i.e. Zoological Record, PubMed, ULIDAT, institutional repositories and so on, providing the three most common formats in online publishing (PDF, HTML, XML)
- High visibility of the work – anyone can read your article at no charge, resulting in *higher citation rates* for the author (see The Effect of Open Access, <http://opcit.eprints.org/oacitation-biblio.html>).
- Greatest possible reduction of Open Access fees and prices for printed copies and reprints.
- Validation of new scientific names under ICZN requirements with “near” simultaneous appearance on the web in e-publications and EOL.

Open Access, in this context, also means that Authors retain the copyright of their articles. According to the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0/>) accepted by *ZooKeys*, Open Access papers may be copied, downloaded, and used for text- and data-mining purposes, provided that such uses are fully attributed and undertaken on a non-commercial basis.

Open Access leads to a much higher visibility and citation rate of the published works (Lawrence 2001, Antelman 2004). Eysenbach (2006) found “*strong evidence that, even in a journal that is widely available in research libraries, OA articles are more immediately recognized and cited by peers than non-OA articles published in the same journal.*” The increase of citation counts of Open Access papers was even found to be “dramatic” by some analysts (Harnad & Brody 2004).

As a business model, Open Access is often termed as “author pays but everyone can read at no charge,” instead of the traditional “publisher pays but everyone has to pay to read” (Suber 2003, 2007). In fact, the currently used model could in many cases be determined to be even worse – “author pays, readers also pay” – in all cases where subscription-based journals also charge for publishing (in the form of page charges). Naturally, authors are not expected to pay for Open Access out of their pockets but from research grants, foundations, and institutional funds. Several funding agencies in the USA and Europe already include grant money for



Open Access publishing in their budget plans. Such a policy has even filtered to high-level decisions of the Council of the European Union. At the Council Meeting in Brussels on 22-23 November 2007, the Council emphasised “*the strategic importance for Europe’s scientific development of current sustainable models for open access to scientific information*”. Furthermore, in the same document the Council recognized that “*effective and long-lasting digital preservation of scientific information is fundamental for the current and future development of European research*” and invited the Member States to ensure by 2010 that “*repositories of scientific information are sustainable and interoperable*” (2832nd COMPETITIVENESS – Internal market, Industry and Research). The increasing demand for Open Access especially concerns scientific results obtained from publicly-funded projects. In this way Society avoids “double payment” to obtain scientific information, first when subsidizing scientific work and, then second, when academic and public libraries pay exorbitantly excessive journal subscription rates.

As taxonomy is concerned, Open Access does not seem to be widely accepted, although at least descriptions of taxa should be placed firmly in the public domain (Agosti & Johnson 2006). The low percentage of Open Access papers in taxonomy (less than 5% according to Agosti & Johnson 2006) can perhaps be explained by four main reasons: (1) limited institutional and grant resources in this field of inquiry; (2) even fewer possibilities for funding of privately-working taxonomists, who often produce excellent results but have no institutional bodies backing them to cover the costs of Open Access; (3) unfamiliarity with Open Access philosophy regarding authors rights, and (4) with the revolutionary changes occurring in the transition from the Web to Web2.0, whereby all the publications can be linked to form one virtual entity (rather than thousands of individuals – see Agosti et al. 2007). However, there are and must be several solutions to this problem in order to enhance Open Access to taxonomic publications as much as is possible.

Publication fees in Open Access journals ensure a barrier-free distribution of the contents and include costs involved in processing, formatting, publishing, indexing, and archiving of the published materials. We understand, however, that many zoologists work privately or continue to enjoy their work after retirement. Therefore, if authors do not have funds to pay such fees, they will have an opportunity to ask for a discount or complete waiver. We do not want fees to prevent the publication of worthy work! Discounts and waivers will be offered to private and retired zoologists, as well as to scientists from low income or lower middle income countries (according to the World Bank country classification). Students, especially in the case of exceptionally good manuscripts, may also request discounts/waivers. Discounts/waivers will be also offered to scientists who actively participate in the review and editorial process. With this, we hope to create an opportunity for all taxonomists, independent of their budgetary constraints, to sample the effect of open access on visibility of their work!



## Editorial scope and policy

*ZooKeys* will consider for publication works in taxonomy in the widest sense, i.e., new descriptions of taxa, if they are accomplished with proper diagnoses, keys and/or revision of at least the species-group level; taxonomic revisions of extant (or “recent”) and fossil animal groups; checklists and catalogues; phylogenetic and evolutionary analyses; papers in descriptive and/or historical biogeography; methodology papers; data mining and literature surveys; monographs, conspectus, atlases; collections of papers, Festschrift volumes, and conference proceedings.

Papers containing identification keys will be accepted with priority. Extensive manuscripts consisting mostly of keys will be considered for publishing, as well.

Several categories of papers will be considered for publishing – original research articles; reviews – longer articles offering a comprehensive overview, historical analysis and/or future perspectives of a topic; monographs and collections of papers with no limit in size, published as “special issues”; short communications, letters and discussion papers; book reviews.

ISBN numbers will be assigned to large monographic papers (*i.e.*, major revisions of taxa), monographs, collections of papers, Festschrift volumes, atlases, checklists, and conspectus.

The main aim in improving dissemination of the published papers will be ISI (Web of Science) listing and gaining impact factor as quickly as possible, indexing in the world’s leading scientific information databases and appropriate repositories.

Today, knowledge is disseminated in various published formats (new taxa descriptions, reviews, revisions, monographs, synopses, etc.). These are nothing more than containers for various kinds of biosystematics information. Each container has a title, authors, abstract, as well as character-state information, occurrence data, images, bibliographic information, etc. Today there are public depositories for much of this information but the containers remain critical as they continue to represent the packages that are counted for purposes of evaluation, merit rewards, tenure decisions, and the like. Recognizing this reality, *ZooKeys* continues the traditional concept of an original source container, with its title, author(s), etc. *ZooKeys* uses the newest and best-practice dissemination model, which includes online PDF, HTML and XML publication, and high-quality printed version. *ZooKeys* incorporates Open Access as mandatory for all contributions. *ZooKeys* is the articulation of a vision that intends to bridge zoological taxonomy with its future. To begin, we will match the best of today (*Zootaxa*), while continually moving forward so as to also become the best for tomorrow.

## References

- Agosti D, Klingenberg C, Sautter G, Johnson N, Stephenson C, Catapano T (2007) Why not let the computer save you time by reading the taxonomic papers for you? *Biológico* 69, suplemento 2: 545-546. <http://hdl.handle.net/10199/15441>



- Agosti D, Johnson NF (2006) Copyright: the new taxonomic impediment. *Bulletin of Zoological Nomenclature* 63: 2.
- Antelman K (2004) Do open access articles have a greater research impact? *College and Research Libraries* 65: 372-382.
- Deans AR, Kawada R (2008) *Alobevania*, a new genus of Neotropical ensign wasps (Hymenoptera: Evaniidae), with three new species: integrating taxonomy with the World Wide Web. *Zootaxa* 1787: 28-44.
- Eysenbach G (2006) Citation Advantage of Open Access Articles. *PLoS Biol* 4(5): e157. doi: 10.1371/journal.pbio.0040157
- Fabricius JC (1775) *Systema entomologiae, sistens insectorum classes, ordines, genera, species, adiectis, synonymis, locis descriptionibus observationibus*. Flensburg and Lipsiae, 832 pp.
- Fisher BL, Smith MA (2008) A Revision of Malagasy Species of *Anochetus* Mayr and *Odonotomachus* Latreille (Hymenoptera: Formicidae). *PLoS ONE* 3(5): e1787. doi: 10.1371/journal.pone.0001787
- Harnat S, Brody T (2004) Comparing the Impact of Open Access (OA) vs. Non-OA Articles in the Same Journals. *D-Lib Magazine* 10 (6). <http://www.dlib.org/dlib/june04/harnad/06harnad.html#Swan-2004a>
- Johnson NF, Masner L, Musetti L, Van Noort S, Rajmohana K, Darling DC, Guidotti A Polaszek A (2008) Revision of world species of the genus *Heptascelio* Kieffer (Hymenoptera: Platygastroidea, Platygastriidae). *Zootaxa* 1776: 1-51.
- Lawrence S (2001) Free online availability substantially increases a paper's impact. *Nature* 411: 521. doi: 10.1038/35079151
- Linnaeus C (1758) *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species cum characteribus differentiis, synonymis, locis*. Editio decima, reformata. Holmiae, 821 pp.
- Polaszek A, Agosti D, Alonso-Zarazaga M, Beccaloni G, Bjørn PdP, Bouchet P, Brothers DJ, Cranbrook G, Evenhuis NL, Godfray HCJ, Johnson NF, Krell F-T, Lipscom D, Lyal CHC, Mace GM, Mawatari S, Miller SE, Minelli A, Morris S, Ng PKL, Patterson DJ, Pyle RL, Robinson NJ, Rogo L, Taverne J, Thompson FC, Tol J van, Wheeler QD & Wilson EO (2005) A universal register for animal names. *Nature* 437: 4. doi: 10.1038/437477a
- Polaszek A, Alonso-Zarazaga M, Bouchet P, Brothers DJ, Evenhuis NL, Krell FT, Lyal CHC, Minelli A, Pyle RL, Robinson N, Thompson FC, van Tol J (2005) ZooBank: the open-access register for zoological taxonomy: Technical Discussion Paper. *Bulletin of Zoological Nomenclature* 62: 210-220.
- Pyle RL, Earle JL, Greene BD (2008) Five new species of the damselfish genus *Chromis* (Perciformes: Labroidae: Pomacentridae) from deep coral reefs in the tropical western Pacific. *Zootaxa* 1671: 3-31.
- Suber P (2003) "Author pays" publishing model. Answering to some objections. *BMJ* 327: 54. doi: 10.1136/bmj.327.7405.54
- Suber P (2007) Open Access Overview. Focusing on open access to peer-reviewed research articles and their preprints. <http://www.earlham.edu/~peters/fos/overview.htm>
- Wheeler QD (2007) Invertebrate systematics or spineless taxonomy? In: Zhang Z-Q, Shear WA (Eds) *Linnaeus Tercentenary: Progress in Invertebrate Taxonomy*. *Zootaxa* 1668: 1-8.
- Wheeler QD (2008) (Ed.) *The new taxonomy*. CRC Press, Boca Raton etc., 237 pp.